

## CSC384 Assignment 3 Written Answers Part 1

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### Question 1

The heuristic value for a state in  $A^*$  is just an estimate of distance between the current state and the goal state. Therefore, when determining the heuristic value for a state in  $A^*$ , we usually consider the possible paths to the goal state from current state and determine the distance based on the paths; However, the heuristic value for a state in game is an estimate of how good the current state is based on possible results (terminal states) the current state may lead to. In this case, there is no goal state. Due to the nature of games, it is usually not possible to determine the heuristic value of a state by considering all possible payoffs it could lead to. Therefore, the heuristic value for a game state is usually determined by features of the states and near future states.

For  $A^*$  search, a heuristic is good if it is monotonic, which means that it should not overestimate the distance between any two states. Monotonicity implies local and global optimality so that there will be no local misleading. Given monotonicity, the heuristic value is good if it is close to the real distance between the current state and the goal state. For game, a heuristic is good if it gives proper estimate by taking into account future game states the current state could lead to and payoffs if possible. In both cases, the heuristic should be relatively easy to obtain since the performance of the algorithm in general should also be considered.

### Question 2

1. According to the score calculating policy of this game, when death is imminent, which means that Pacman cannot get any food before death, it will have suicidal tendencies because that results in higher final score. Note that the score decreases over time steps if no food/capsule/scared ghost is taken.

2. Note: for this question, I assume that the true minimax value is returned from the terminal state and the minimax value can be negative.

In this case, squaring a negative value will make it positive so that the relative magnitude order of nodes may not be preserved. Therefore, answers for a), b) and c) are all "Not same".

a) Not same.

b) Not same.

c) Not same.

### Question 3

1.

a) Using alpha beta pruning, we can search twice as deep (i.e. 2d).

The time complexity for pure minimax strategy (with no pruning) is  $O(b^d)$ . However, in the best-case scenario, the time complexity of alpha beta pruning is  $O(b^{(d/2)})$ . Therefore, using alpha beta pruning, we can **search twice as deep**.

**b)** In the worst-case scenario, alpha-beta is able to search to **the same depth** as pure minimax strategy (i.e.  $d$ ).

This is because in the worst case, we need to examine all nodes (i.e. no pruning) and the time complexity of alpha beta pruning becomes  $O(b^d)$ , which is the same as pure minimax strategy.

**2. False**

Alpha beta only prunes paths that will not be chosen under minimax strategy. It will not change the minimax value of the root node.